

Christiano
C06, Fall 1999
September 29

Lecture #3: More on Exchange Rates

1. The Foreign Exchange Market.

- (a) Exchange Rates Move A Lot, continued. We learned last time that exchange rates move around a lot and presented evidence that suggests the movements matter. Here is another example, which shows the trouble that exchange rate movements can create for business people. It's another car maker example. This time, it's about an American car maker who sells cars to dealers in Germany. Let E denote the exchange rate, in German Marks per dollar (in the notation of the book, E is $E_{DM/\$}$). Here is the situation of the American car manufacturer. To generate an acceptable return for shareholders, the manufacturer must earn 10 percent over costs. Thus, m from the example of lecture 2 must be $m = 0.10$. Suppose the dollar costs of making a car, C , are determined in advance, by contracts with workers and by contracts which specify what price parts suppliers will receive. Also, let P^{GER} denote the price, in German Marks, that the manufacturer receives for each car from German dealers. This too is determined in advance by contract. Now, remember the formula,

$$E \times P^{GER} = (1 + m)C.$$

This shows how the dollar receipts from a car (the exchange rate times the German Mark receipts) are allocated between costs, C , profits, mC . Since P^{GER} and C are determined in advance by contract, and E is determined by broader market forces, over which the manufacturer has no control, you can think of this equation as determining m . That is,

$$m = E \frac{P^{GER}}{C} - 1.$$

Suppose P^{GER} and C are determined three months before the American manufacturer actually receives delivery of the dollars, $E \times P^{GER}$. This creates a problem for the manufacturer at the time P^{GER} and C are set in contract negotiations. Since they don't know what E will be, they in effect don't know what m will be. If the uncertainty in E were small, this would translate into

just a little uncertainty in m , and no one would care. But, let's see how much uncertainty there is in E in practice.

The attached Figure 1 shows the average value of E during each quarter (a 'quarter' is three months) over the period 1971 to the present. Note that, overall, the US dollar has depreciated, with a big exception in the middle 1980s, when the dollar appreciated sharply relative to the German Mark. These longer term trends in the exchange rate are the subject of later lectures. More to the point for present purposes is Figure 2, which displays the quarterly percent change in the exchange rate, that is, if E_t denotes the exchange rate in quarter t , then, Figure 2 displays E_t/E_{t-1} . Note that this ratio appears to fluctuate between 1.05 and 0.95. This means that it is not unusual for the exchange rate to jump from one quarter to the next by 5 percent, or fall by 5 percent. Let's see how this translates into uncertainty in the car manufacturer's profit margin.

Imagine the following timing. Contracts are set in one quarter, and then revenues come in during the following quarter. The evidence suggests that, at the time of signing, the amount of uncertainty in next quarter's exchange rate is well captured by the following simple setup. Suppose that next period's exchange rate could be E^1 , E^2 or E^3 , where $E^1 = 2.10$, $E^2 = 2.00$, and $E^3 = 1.90$, with probability $1/3$ each. Thus, the forecasted value of the exchange rate is $((2.10+2.00+1.90)/3=2)$ is 2. This is the current actual value of E , rounded up (see Figure 1). Also, the example captures the notion that it would not be surprising if the actual exchange rate differed from the forecasted value by 5 percent.

Suppose P^{GER} is set so that, given C , $m = 0.10$ if the forecasted value of the exchange rate occurs. Then, what values will m take on if $E^1 = 2.10$, $E^2 = 2.00$, or $E^3 = 1.90$? Denote the values of m corresponding to these three possible values of E by m^1 , m^2 , m^3 , respectively. Then,

$$\begin{aligned} m^1 &= \frac{E^1}{E^2}(1 + m^2) - 1 = 0.155 \\ m^2 &= .10 \\ m^3 &= \frac{E^3}{E^2}(1 + m^2) - 1 = 0.045. \end{aligned}$$

So, the five percent uncertainty in E translates into uncertainty in profits on the order of 50 percent $((0.155 \times C)/(0.10 \times C)=1.55)$! This is a lot of uncertainty, and businesses would like to do something to get this uncertainty down.

In reality, the business impact of the uncertainty in exchange rates is likely to be even bigger than what the previous example suggests. That's because contracts are often negotiated much further in advance than just one quarter. For example, most wage agreements extend for a year, and many contracts actually go for three years. The uncertainty in the one-year-ahead forecast of an exchange rate is roughly four times greater than the uncertainty in the one-quarter-ahead forecast. So, if we widened¹ the spread in E to $E^1 = 2.2$, $E^2 = 2$, $E^3 = 1.8$, then $m^1 = 0.21$, $m^2 = 0.10$, $m^3 = -0.01$. That is, if the low exchange rate is realized, revenues would be so low that shareholders would have to actually mail in checks to the manufacturer to make sure it could pay its bills! The fluctuations in profits in this example are obviously enormous. The point is that the example is not particularly unrealistic.

- (b) The market where traders directly exchange different currencies is called the 'spot market'. As the previous discussion suggests, business people are likely to be nervous about doing all their currency trading in the spot market when they have to make other decisions in advance. In such cases, they have an incentive to find an alternative to the spot market, which allows them reduce or eliminate the uncertainties in their cash flow arising from spot exchange rate uncertainty. Not surprisingly, the appropriate markets have come into being.

Markets exist where people can commit today to exchanging currencies in the future at a specific rate of exchange. Thus, the manufacturer in the previous example could try and find someone who is willing to commit to giving them dollars in exchange for Marks (i.e., enter into a 'forward contract') at some mutually satisfactory rate of exchange three months from now. In this way (for a fee, of course!), the manufacturer can eliminate *all* exchange rate uncertainty. The exact exchange rate and fees traders are likely to settle on in the forward market will depend in part on how many traders there are on each side of the market and how they

¹I came up with this as follows. A measure of the uncertainty in the exchange rate implied by the model in the example is the variance. The variance is

$$\text{Var}(E) = \frac{1}{3} (E^1 - E^2)^2 + \frac{1}{3} (E^2 - E^3)^2 + \frac{1}{3} (E^3 - E^2)^2$$

or,

$$\text{Var}(E) = \frac{2}{3} (0.1)^2.$$

This variance is increased by a factor of four if 0.1 is replaced by 0.2. That's what I did in the example.

feel about the spot market. If one side of the market stands to lose more from the uncertainties of the spot market than the other side, then the laws of bargaining dictate that they are likely to get the worst deal. Pages 339-341 discuss these issues some more.

2. Interest Parity Condition.

(a) Financial Assets: A Piece of paper that entitles the holder to a stream of payments in the future. One measure of the value of an asset then, is its expected ‘rate of return’, which measures how much you get out of it. Below is a discussion of rates of return. It shows that the rate of return on an asset depends on what units you measure that rate of return in. It also shows that assets will differ in terms of the certainty of its rate of return. Finally, assets also differ in terms of their ‘liquidity’: the more liquid an asset the easier it is to find a buyer in case you need to sell it. For example, US government debt is highly liquid. The market for that is so highly developed and there are so many people in it all the time, that US government debt is as easy to dump in case you have to, as it is to dump regular currency. The IOU I gave to my colleague yesterday in exchange for lunch money is completely illiquid.

i. Nominal return on a financial asset: the one period nominal return on an asset is the amount of money you get from holding it one period and then selling it next period at the price prevailing then, divided by the amount of money you paid for it today, P :

$$\text{nominal return} = \frac{D + P'}{P} = 1 + R,$$

where D is the dollar payment you get from holding the asset, and R is the (net) nominal return. The asset could be a bond, in which case D is an interest payment, or a share in a corporation, in which case D would be a dividend check.

ii. Real return on a financial asset: what you get, in terms of goods, for holding an asset for one period, divided by what you give up, in goods, to acquire the asset. The goods value of \$1 is just $1/P_c$, where P_c is the price of a good. In practice, P_c is the price of a basket of goods. An example is the consumer price index, which is the price of buying a specific basket of goods (so many apples, so much bread, so much fuel oil, etc.) that government economists think resembles the mix of

goods Americans actually buy.² So, if the price of a basket is $P_c = \$2$, then with one dollar you can buy $1/P_c = 1/2$ of one basket. Similarly, if the price of a given asset is P dollars, then that corresponds to P/P_c baskets of goods. Also, if the monetary payoff of holding the asset one period and then selling it is $D + P'$, then that payoff in terms of baskets of goods is $(D + P')/P'_c$ where P'_c is next period's price index. So, now we say what the real return on an asset is:

$$\text{real return} = \frac{(D + P')/P'_c}{P/P_c} = (1 + R) \frac{P_c}{P'_c} = \frac{1 + R}{1 + \pi} \approx 1 + R - \pi,$$

where R is the nominal return defined above and π is the inflation rate, $1 + \pi = P'_c/P_c$. The ' \approx ' means 'almost equals'. You can verify this by plugging in some (not too big!) values for R and π . So, the real rate of return on an asset is the nominal rate of return, minus the inflation rate. You can see here, that even if R is known at the time an asset is acquired (typically, it is not known - in the case of a bond, D may be known but P' is not likely to be known; in the case of equity, neither D nor P' are known), there will still be uncertainty in its rate of return stemming from uncertainty there is in π .

- iii. The return on a foreign currency asset. In thinking about whether to invest in a US dollar asset or a foreign asset, it is important to get the returns in the same units. This is because, as the previous examples indicate, the units matter. So, imagine an American contemplating two assets: a US asset which has a nominal, US dollar rate of return, $R_{\$}$, and a German asset, which has a nominal return, in German marks, of R_{DM} . As it stands now, the two assets are in different units. To compare them they have to be put in the same units. So, let's put them in US dollar units. To acquire one unit of the foreign asset, the American has to pay P^{DM} German Marks. In dollar terms, the American has to pay $E \times P^{DM}$ dollars, where E denotes the number of Dollars per German Mark in the spot exchange rate market (i.e., this is $E_{\$/DM}$ in the notation of the book). So, the price, to an American, of the German asset, is $E \times P^{DM}$ dollars. The

²The actual level of P_c doesn't mean much, of course, since we don't know exactly how many of each the goods the government economists have in the basket. But, changes in P_c are of interest, since they indicate that the basket of goods that Americans buy has changed in cost.

payoff, next period, in German Marks, is $D^{DM} + P^{DM'}$, which translates into $(D^{DM} + P^{DM'}) \times E'$ dollars next period. Here, E' denotes next period's exchange rate. So, the rate of return, in US dollars, on the German asset is:

$$1+R = \frac{(D^{DM} + P^{DM'}) \times E'}{P^{DM} \times E} = (1+R_{DM}) \frac{E'}{E} \approx 1+R_{DM} + \frac{E' - E}{E}.$$

In practice, E' is not known at the time the asset purchase decision is made, so it makes sense to replace E' by E^e :

$$R = R_{DM} + \frac{E^e - E}{E}.$$

This says that the US dollar return on a German Asset equals the German Mark denominated return on the asset, plus the anticipated rate of appreciation of the Mark (i.e., a rise in $E_{\$/DM}$ means a *depreciation* in the value of the US dollar and an *appreciation* in the value of the German Mark). The dollar return on a German asset is the sum of the German Mark return and the return on holding German marks.

With a lot of people interacting in foreign exchange markets, we don't expect rates of return on different assets to be very different. In particular, we don't expect rates of return on US denominated assets to differ much from rates of return on German Mark denominated assets. This leads to the interest parity condition, the idea that $R_{\$}$ must equal the US dollar denominated return on German assets: $R_{\$} = R_{DM} + \frac{E^e - E}{E}$, or

$$R_{\$} - R_{DM} = \frac{E^e - E}{E}.$$

In words, if the Dollar return on US assets is higher than the Mark return on German assets, it must be that the return the German mark is expected to be positive and large enough to cover the difference. If this were not true, say because $E^e = E$, then no one would want to hold German assets. They would all hold US assets only. Of course, in the process of trying to acquiring the US assets, they would sell Marks and buy Dollars. In the process, they would drive down E and (assuming E^e does not change much) *force* the interest parity condition to hold.

3. Exchange rate determination in the Short Run. As suggested by the last comment, the interest parity condition gives us a way to think

about how the exchange rate is determined in the short run. Suppose R_{DM} and E^e are just given for now. Suppose the US monetary authorities cut the US interest rate, R_s . What will happen to the current exchange rate, E ? Suppose we start in a situation where covered interest rate parity holds. With the fall in R_s , but *before* any change in E (I'm holding E^e and R_{DM} constant from beginning to end of this experiment), German assets will look much more attractive than American assets to everyone. So, people will sell US dollars and buy Marks to take advantage of the higher rates there. This process will drive down the value of a dollar, sending E down and therefore, driving $(E^e - E)/E$ down. That is, the depreciation of the US dollar will (given that E^e is being held constant) create an anticipated appreciation of the dollar. This will happen up to the point where covered interest parity holds again. Thus, anticipated dollar appreciation will make up for the now relatively low nominal return on US assets.

Figure 1: German Mark per Dollar

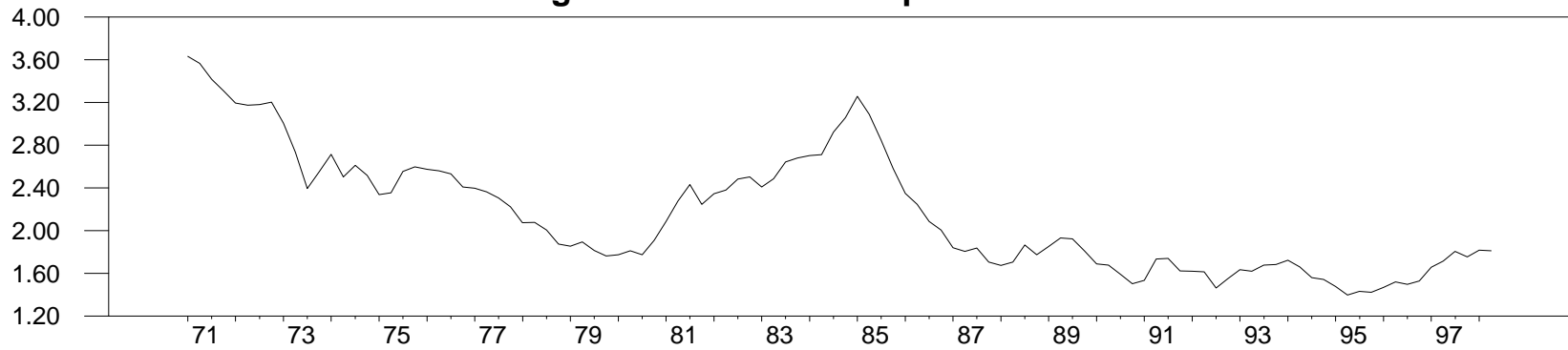


Figure 2: Percent Change, over Three Months, in DM Per Dollar

